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Koakutsu

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(54) **TONER TRANSPORT STRUCTURE AND IMAGE FORMING APPARATUS**

(71) Applicant: **FUJI XEROX CO., LTD.**, Minato-ku, Tokyo (JP)

(72) Inventor: **Masafumi Koakutsu**, Kanagawa (JP)

(73) Assignee: **FUJI XEROX CO., LTD.**, Tokyo (JP)

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G03G 15/08 (2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2008/0253804 A1* 10/2008 Furuta et al. 399/119
2012/0263502 A1* 10/2012 Nakaue et al. 399/254

FOREIGN PATENT DOCUMENTS

JP 2008-083287 A 4/2008
JP 2008-287214 A 11/2008

* cited by examiner

Primary Examiner — Roy Y Yi
(74) *Attorney, Agent, or Firm* — Sughrue Mion, PLLC

(57) **ABSTRACT**

A toner transport structure has a transport passage that extends in an intersecting direction that intersects a vertical direction. The toner transport structure includes a path member that has an upper end and a lower end, an exit on a lower end side thereof, and an entrance on an upper end side thereof. The exit and the entrance have respective openings, and the path member guides toner downward in the vertical direction. The toner transport structure also includes a transport member disposed in the transport passage that is connected to the exit on the lower end side of the path member. The transport member transports along the transport passage the toner having been guided downward by the path member. In the toner transport structure, an area of the opening at the exit is larger than an area of the opening at the entrance.

6 Claims, 7 Drawing Sheets

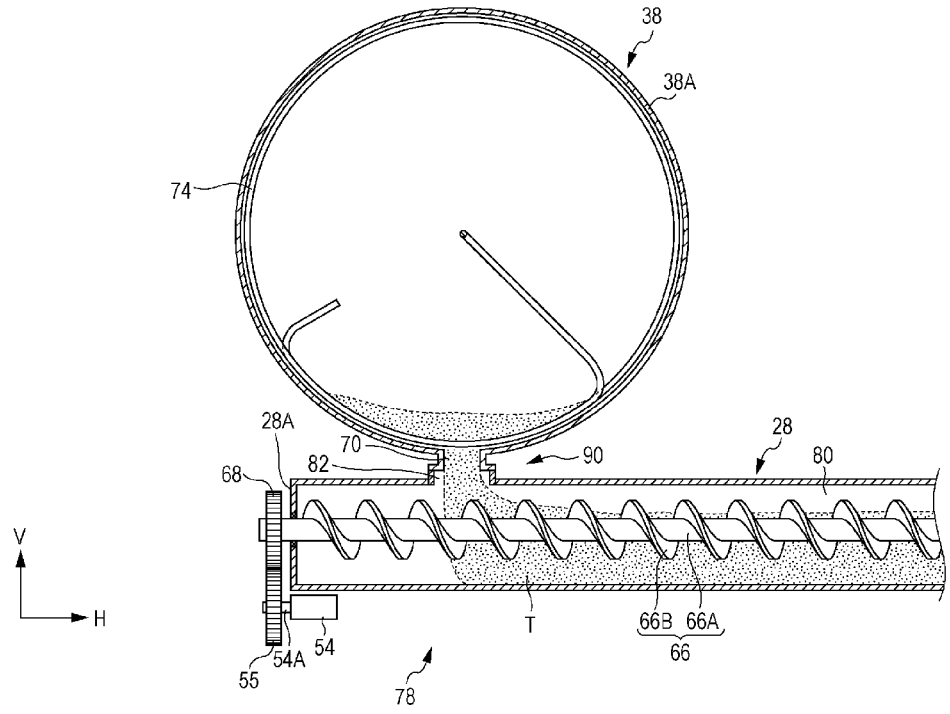
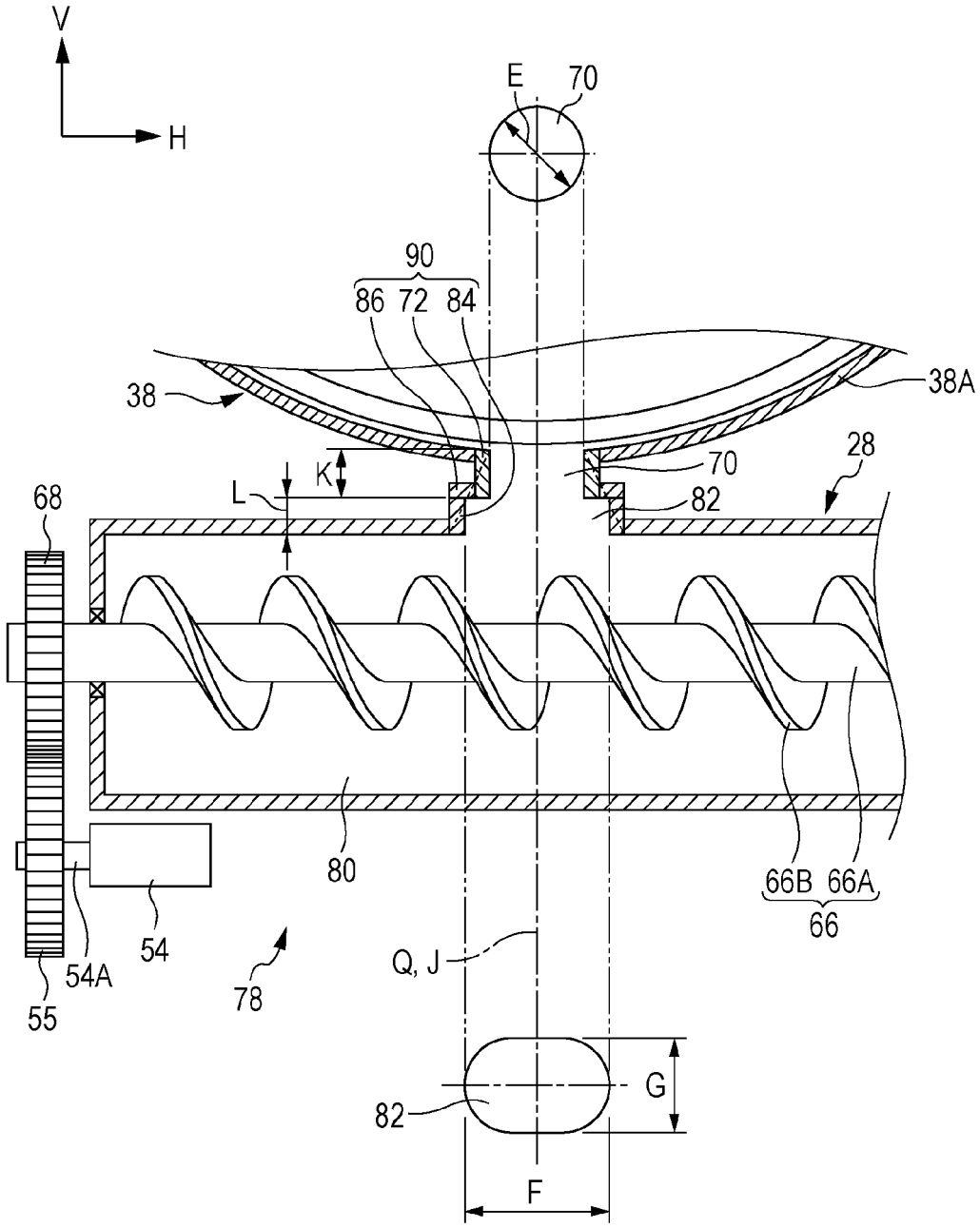


FIG. 1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54A
55
78
Q, J
82
G
F

FIG. 2

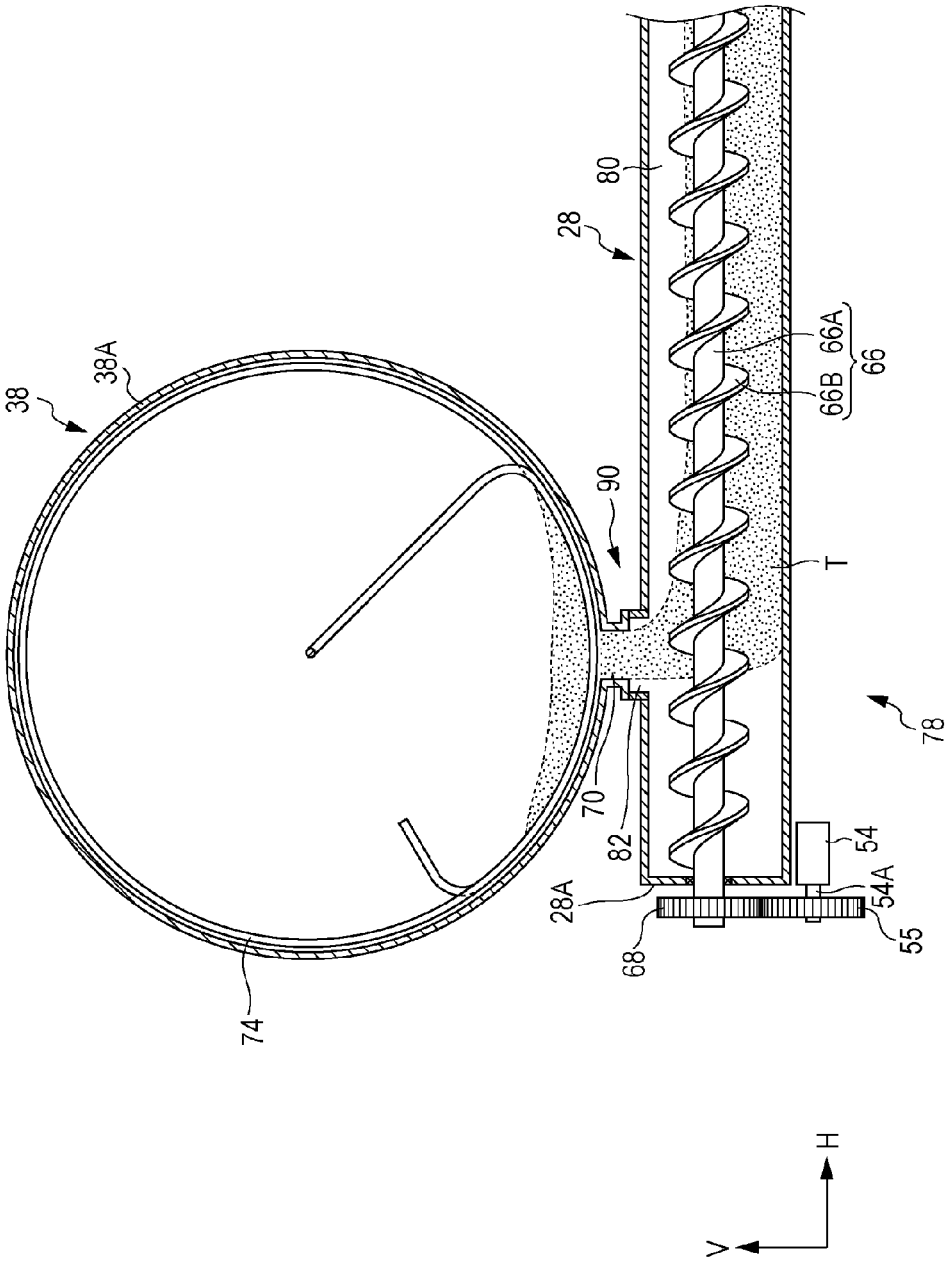

FIG. 3

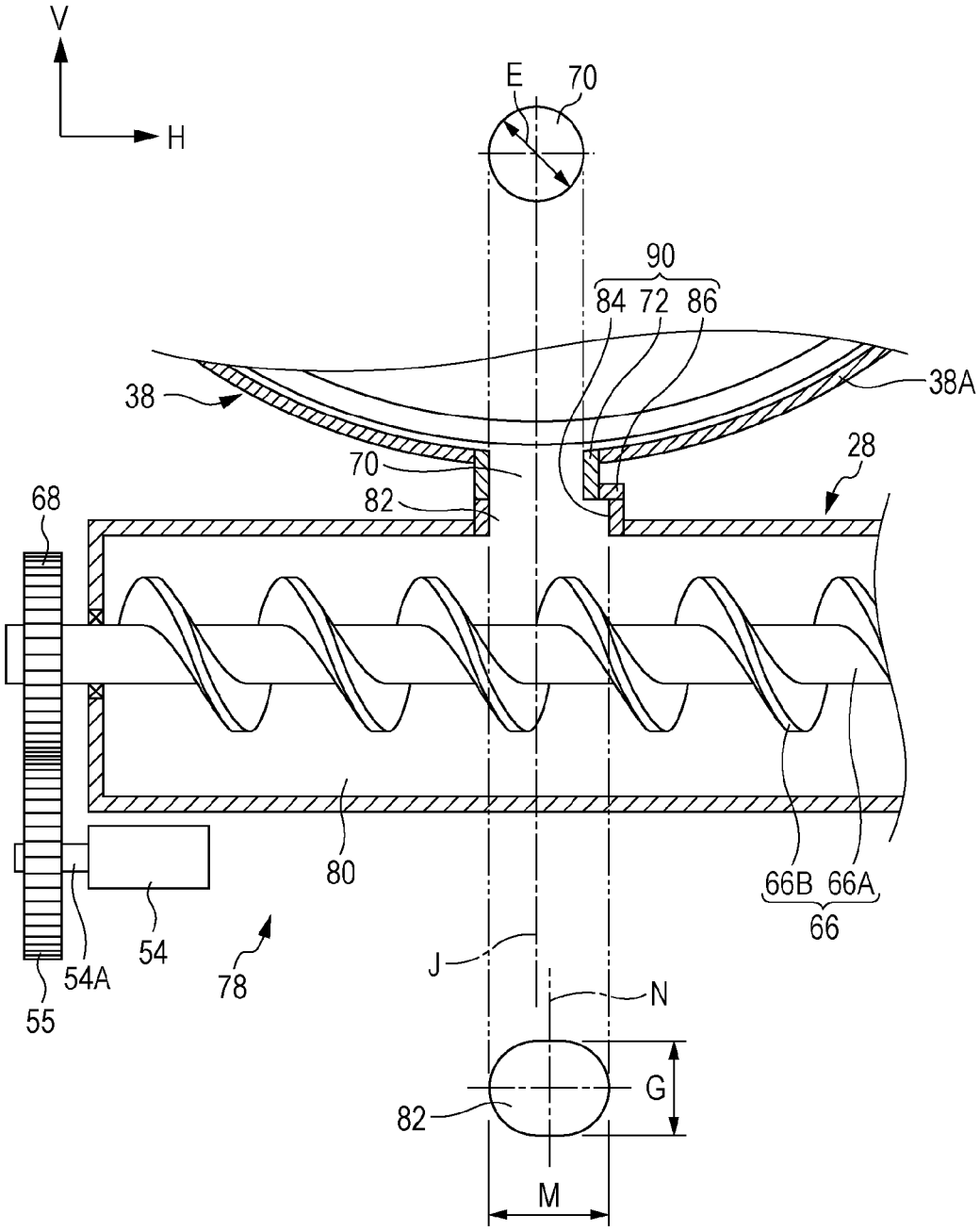
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FIG. 4A

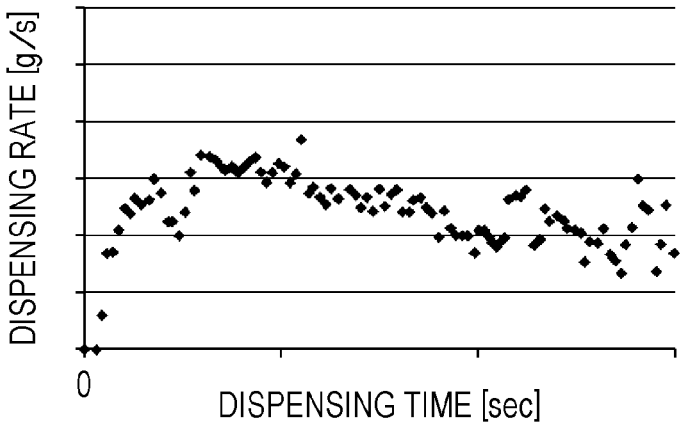


FIG. 4B

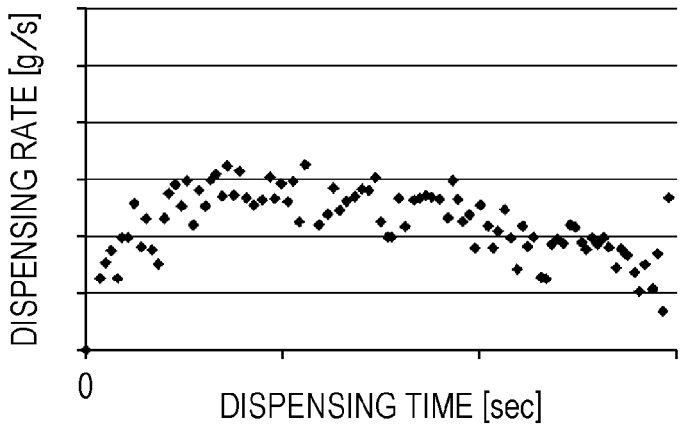


FIG. 4C

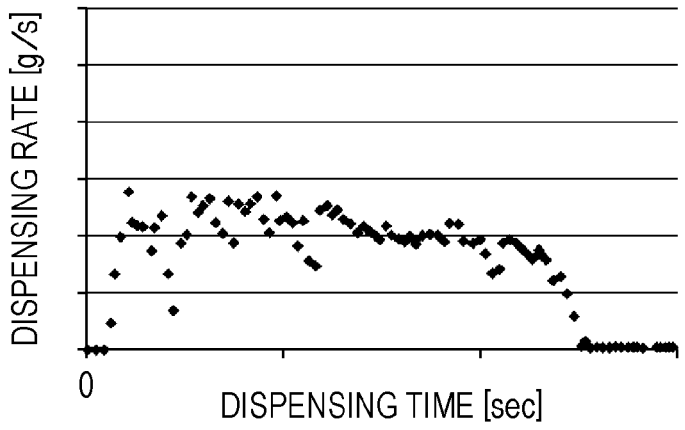


FIG. 5

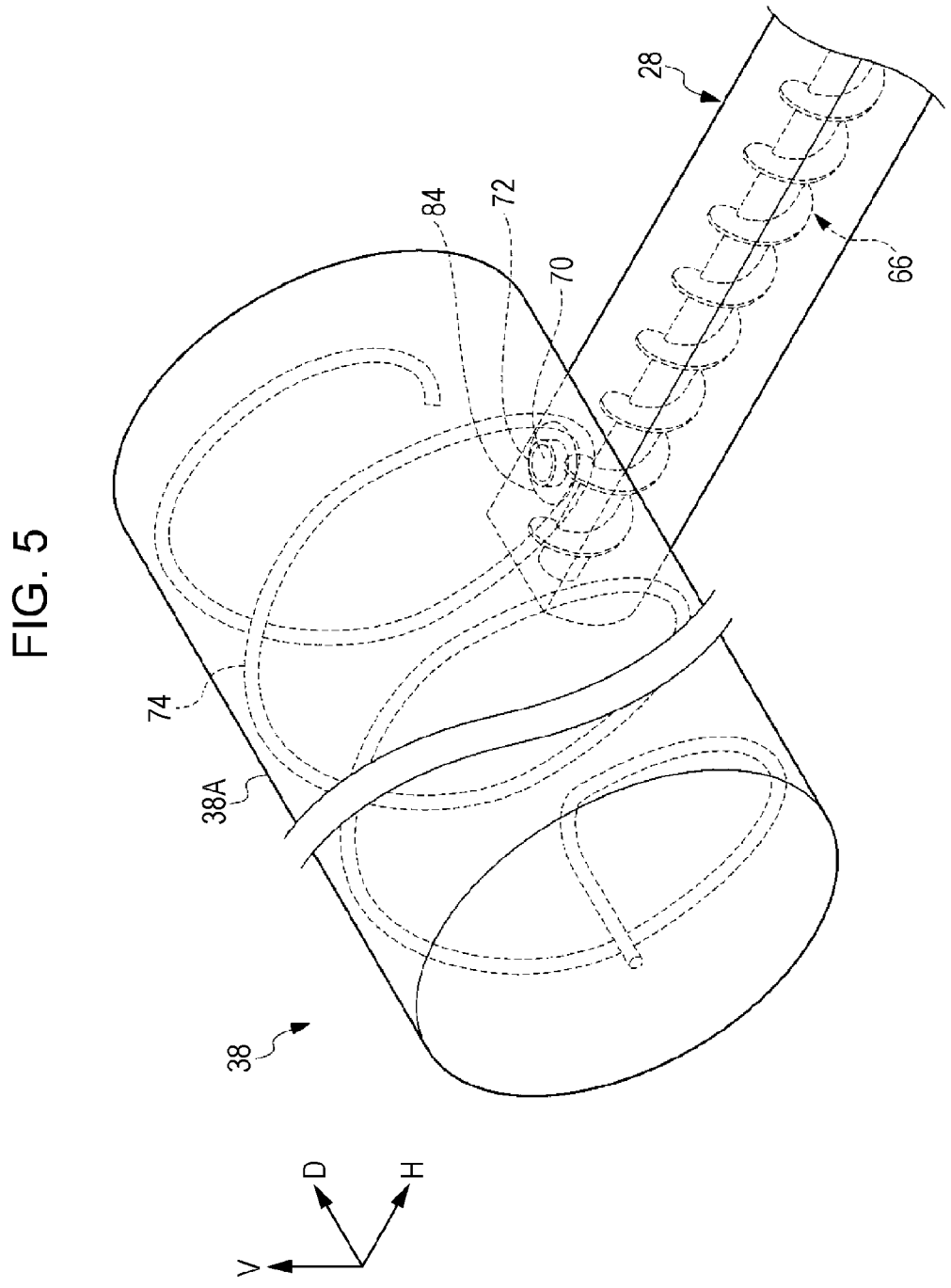
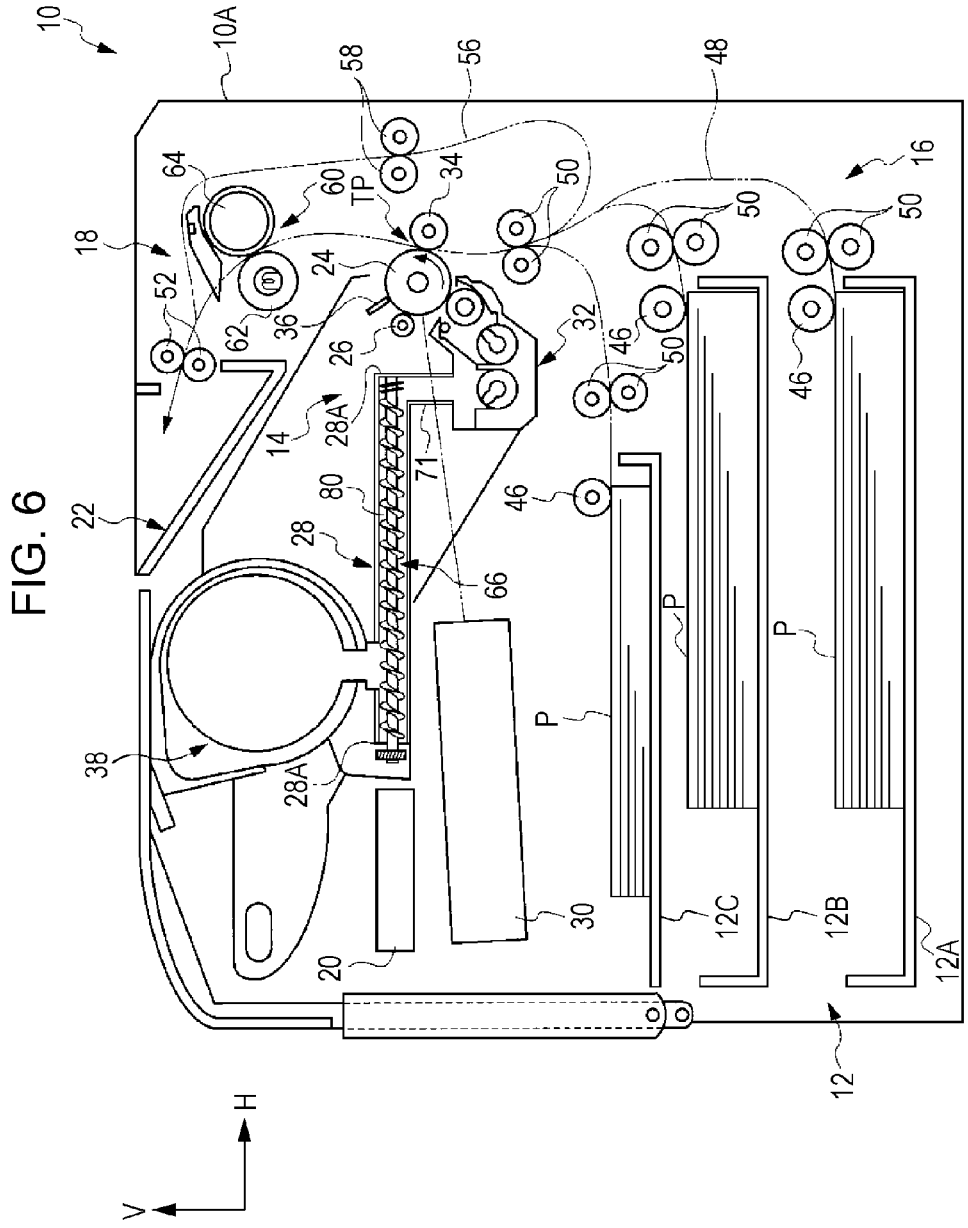


FIG. 6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10A
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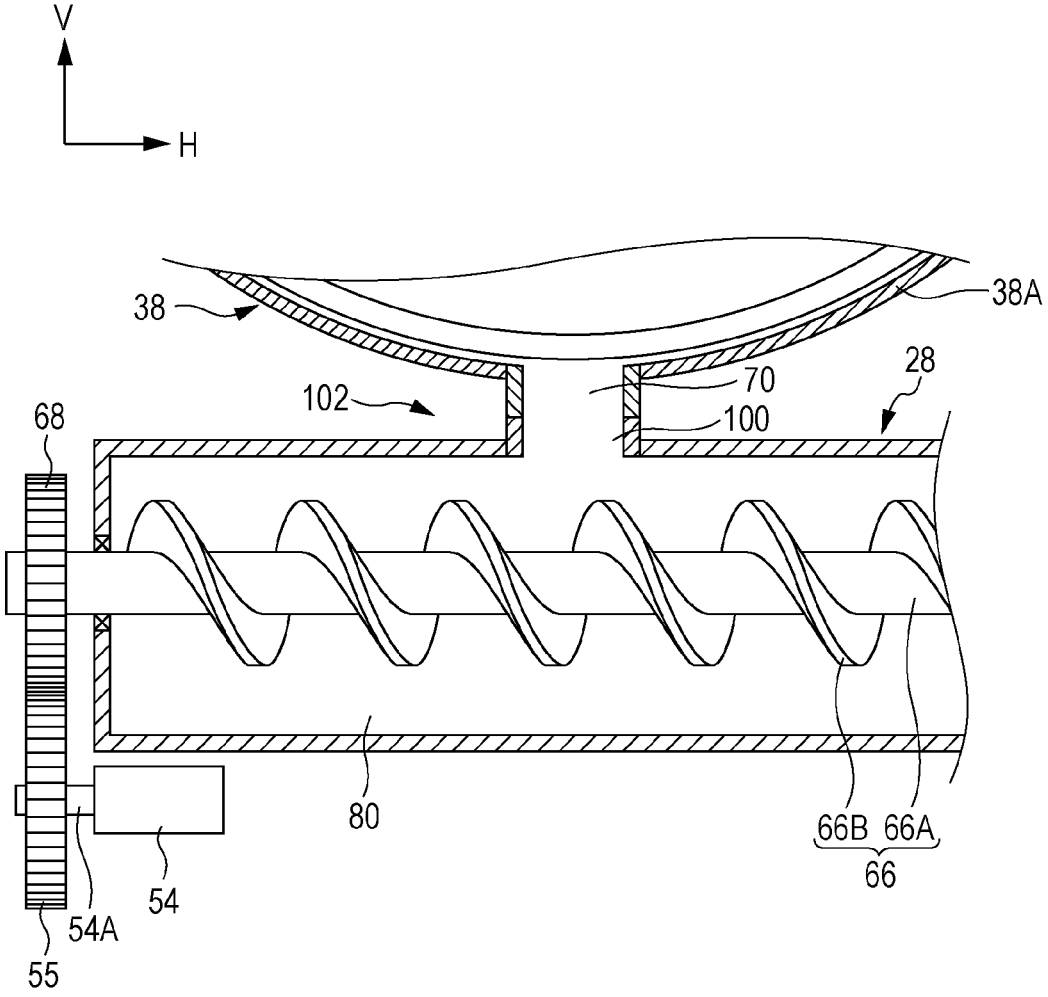
V

FIG. 7



TONER TRANSPORT STRUCTURE AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2012-230181 filed Oct. 17, 2012.

BACKGROUND

Technical Field

The present invention relates to a toner transport structure and an image forming apparatus.

SUMMARY

A toner transport structure according to an aspect of the present invention has a transport passage that extends in an intersecting direction that intersects a vertical direction. The toner transport structure includes a path member that has an upper end and a lower end, an exit on a lower end side thereof, and an entrance on an upper end side thereof. The exit and the entrance have respective openings, and the path member guides toner downward in the vertical direction. The toner transport structure also includes a transport member disposed in the transport passage that is connected to the exit on the lower end side of the path member. The transport member transports along the transport passage the toner having been guided downward by the path member. In the toner transport structure, an area of the opening at the exit is larger than an area of the opening at the entrance.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiment of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** is an enlarged sectional view illustrating a toner transport structure according to an exemplary embodiment of the present invention;

FIG. **2** is a sectional view illustrating the toner transport structure according to the exemplary embodiment of the present invention;

FIG. **3** is an enlarged sectional view illustrating an alternative example of the toner transport structure according to the exemplary embodiment of the present invention;

FIGS. **4**A, **4**B, and **4**C are graphs illustrating results of evaluation of examples of the toner transport structure according to the exemplary embodiment of the present invention and a comparative example of a toner transport structure;

FIG. **5** is a perspective view illustrating the toner transport structure according to the exemplary embodiment of the present invention;

FIG. **6** illustrates a general structure of an image forming apparatus according to the exemplary embodiment of the present invention; and

FIG. **7** is an enlarged sectional view of a toner transport structure, which is a comparative example in comparison with the toner transport structure according to the exemplary embodiment of the present invention.

DETAILED DESCRIPTION

Examples of a toner transport structure according to an exemplary embodiment of the present invention and an example of an image forming apparatus equipped with the toner transport structure will be described below with reference to FIGS. **1** to **7**. In FIGS. **1** to **7**, arrow V indicates the vertical direction, arrow H indicates a direction which is the horizontal direction and an apparatus width direction (left-right direction of the apparatus), and arrow D indicates a direction which is the horizontal direction and an apparatus depth direction.

General Structure

As illustrated in FIG. **6**, an image forming apparatus **10** includes an apparatus body **10**A that houses components of the image forming apparatus **10** therein. A container section **12**, a transport section **16**, an image forming section **14**, a fixing unit **18**, and a controller **20** are provided in the apparatus body **10**A. The container section **12** contains a sheet medium P serving as a recording medium. The transport section **16** transports the sheet medium P contained in the container section **12**. The image forming section **14** forms a toner image on the sheet medium P being transported. The fixing unit **18** fixes onto the sheet medium P the toner image having been formed on the sheet medium P by the image forming section **14**. The controller **20** controls operations of the components of the image forming apparatus **10**.

An output unit **22** is formed in an upper portion of the apparatus body **10**A. The sheet medium P, onto which an image has been fixed by the fixing unit **18**, is ejected to the output unit **22**.

Image Forming Section

The image forming section **14** is disposed near the center in the up-down direction in the apparatus body **10**A. The image forming section **14** includes an image carrying body **24** that holds an image.

The image carrying body **24** has a cylindrical shape and is rotated in a single direction (counterclockwise in FIG. **6**). A charging roller **26**, an exposure device **30**, a developing device **32**, and a transfer roller **34** are disposed around the image carrying body **24** in order from an upstream side in the rotational direction of the image carrying body **24**. The charging roller **26** charges the image carrying body **24**. The exposure device **30** exposes the image carrying body **24**, which has been charged by the charging roller **26**, with light so that an electrostatic latent image is formed on the image carrying body **24**. The developing device **32** develops the electrostatic latent image formed by the exposure device **30** with a developer G that contains a toner T and carrier, thereby forming, for example, a black toner image. The transfer roller **34** transfers the black toner image having been formed on the image carrying body **24** by the developing device **32** onto the sheet medium P.

Furthermore, a collection blade **36** is provided so as to be in contact with an outer circumferential surface of the image carrying body **24**. The collection blade **36** collects the toner T that has not been transferred onto the sheet medium P by the transfer roller **34** and remains on the image carrying body **24**.

The transfer roller **34** opposes the image carrying body **24**. The transfer roller **34** and the image carrying body **24** pinch the sheet medium P therebetween while being rotated so that the sheet medium P is transported from a lower side to the upper side. A transfer position TP, where the toner image formed on the image carrying body **24** is transferred onto the sheet medium P, is defined at a nip between the transfer roller **34** and the image carrying body **24**.

A toner cartridge **38** that contains toner is disposed above the exposure device **30**. A transport pipe **28** is provided in the image forming section **14**. The transport pipe **28** transports the toner T contained in the toner cartridge **38** to the devel-

oping device **32**. The details of the structures of the toner cartridge **38** and the transport pipe **28** will be described later.

Containing Section

The container section **12** is disposed below the image forming section **14**. The container section **12** includes loading members **12**A, **12**B, and **12**C arranged in the up-down direction. The sheet media P are loaded in the loading members **12**A, **12**B, and **12**C. Each of the loading members **12**A, **12**B, and **12**C may be drawn toward the apparatus front side in the apparatus depth direction. When the loading members **12**A, **12**B, and **12**C are drawn to the apparatus front side, the loading members **12**A, **12**B, and **12**C may be replenished with the sheet media P.

Transport Section

The transport section **16** is disposed beside the container section **12** and the image forming section **14**. The transport section **16** includes pickup rollers **46** and transport rollers **50**. An uppermost sheet medium P loaded in each of the loading members **12**A, **12**B, and **12**C is fed by a corresponding one of the pickup rollers **46**. The sheet medium P fed by a corresponding one of the pickup rollers **46** is transported along a transport path **48** for the sheet medium P by the plural transport rollers **50**.

The transport section **16** also includes ejection rollers **52** that eject each sheet medium P, onto which a toner image has been fixed by the fixing unit **18**, to the output unit **22**.

The transport section **16** further includes transport rollers **58**. The transport rollers **58** transport the sheet medium P along an inversion transport path **56** so that the front and back sides of the sheet medium P, onto one side (front side) of which a toner image has been fixed, is inverted and so that the sheet medium P is transported again to the transfer position TP.

The inversion transport path **56** is disposed on one side of the transfer roller **34** opposite to the other side of the transfer roller **34** where the image carrying body **24** is disposed. When images are formed on both sides of the sheet medium P, the sheet medium P, onto one side of which a toner image has been fixed, is transported backward by the ejection rollers **52** and guided to the inversion transport path **56**. The front and back sides of the sheet medium P are inverted by being transported along the inversion transport path **56** by the transport rollers **58**. The inverted sheet medium P is transported again to the transfer position TP.

Fixing Unit

The fixing unit **18** is disposed above the image forming section **14**. The fixing unit **18** includes a fixing device **60**. The fixing device **60** includes a heating roller **62** and a pressure roller **64**. The heating roller **62** heats a toner image transferred onto the sheet medium P while being rotated by a rotational force transmitted thereto from a motor (not shown). The pressure roller **64** is in contact with the heating roller **62** and rotated (revolved) by the heating roller **62**. The pressure roller **64** and the heating roller **62** transport the sheet medium P while pinching the sheet medium P therebetween.

Operation of General Structure

Next, image forming operations in which an image is formed on the sheet medium P are described.

In the container section **12** and the transport section **16**, the sheet medium P fed from one of the loading members **12**A, **12**B, and **12**C by the pickup rollers **46** is transported to the transfer position TP using the plural transport rollers **50**.

In the image forming section **14**, the image carrying body **24** is charged by the charging roller **26**, and then exposed to light by the exposure device **30**, thereby an electrostatic latent image is formed on the image carrying body **24**. The electrostatic latent image is developed by the developing device **32** so as to form a black toner image on the image carrying body **24**. The black toner image is transferred onto the sheet medium P having been transported to the transfer position TP by the transfer roller **34**.

The sheet medium P, onto which the toner image has been transferred, is transported to the fixing device **60**. The toner image having been transferred onto the sheet medium P is fixed onto the sheet medium P by the fixing device **60**. In the case in which an image is formed only on one side of the sheet medium P, the sheet medium P is ejected to the output unit **22** by the ejection rollers **52** after the toner image has been fixed onto the sheet medium P.

In contrast, in the case where images are formed on both sides of the sheet medium P, the sheet medium P, onto one side (front side) of which a toner image has been fixed, is transported backward by the ejection rollers **52** to the inversion transport path **56**. By transporting the sheet medium P along the inversion transport path **56** using the transport rollers **58**, the front and back sides of the sheet medium P are inverted. The sheet medium P is again transported to the transfer position TP from the inversion transport path **56**, and a toner image is formed on the back side of the sheet medium P, onto which no toner image has been formed, in a way similar to the way in which the toner image has been formed on the front side. Then, the sheet medium P is ejected to the output unit **22** by the ejection rollers **52**. A series of image forming operations are performed as stated above.

Detailed Structure

Next, in order to describe a toner transport structure **78**, which transports the toner T in an intersecting direction that intersects the vertical direction, the structures of the toner cartridge **38**, the transport pipe **28**, and the like are initially described.

The toner cartridge **38** has a cylindrical shape. Opening a maintenance door (not shown), which is provided in the apparatus body **10**A, so as to open the interior of the apparatus body **10**A to the outside of the apparatus body **10**A allows the user to draw the toner cartridge **38** toward the apparatus front side in the apparatus depth direction. Then, the toner cartridge **38** is detached from the apparatus body **10**A by being drawn toward the apparatus front side by the user.

In this structure, when the toner cartridge **38** runs short of the toner T contained therein due to supplying the toner T to the developing device **32** through the transport pipe **28**, the user detaches the toner cartridge **38** attached to the apparatus body **10**A from the apparatus body **10**A. Then, when the user causes a new toner cartridge **38** to oppose a toner cartridge attachment portion and moves the toner cartridge **38** toward the rear side of the apparatus in the apparatus depth direction, the new toner cartridge **38** is attached to the apparatus body **10**A.

Toner Cartridge

As illustrated in FIG. **5**, the toner cartridge **38** that contains the toner T therein has a cylindrical shape that extends in the apparatus depth direction. An outlet path **70**, through which the toner T contained in the toner cartridge **38** is transported to the transport pipe **28**, is formed in a lower surface of a housing **38**A on the rear side of the apparatus in the apparatus depth direction. The housing **38**A defines a housing of the toner cartridge **38**. The details of the outlet path **70** will be described later.

A spiral-shaped agitator **74** is disposed in the housing **38**A. The agitator **74** is rotated by a rotational force transmitted thereto from a drive source (not shown) and transports the toner T in the housing **38**A toward the outlet path **70** while agitating the toner T.

Transport Pipe

The transport pipe **28** is disposed below the toner cartridge **38**. The transport pipe **28** receives the toner T from the toner cartridge **38** through the outlet path **70** and an inlet path **82**, which will be described later, and supplies the received toner T to the developing device **32**. Specifically, as illustrated in FIG. **6**, the transport pipe **28** extends in the intersecting direction (a direction that matches an apparatus width direction in the present exemplary embodiment) that intersects the vertical direction so as to be directed from the lower side of the toner cartridge **38** toward the developing device **32**.

As illustrated in FIGS. **2** and **6**, a transport passage **80** is defined inside the transport pipe **28** that extends in the intersecting direction. The toner T is transported to the developing device **32** through the transport passage **80**. A transport auger **66** is disposed in the transport passage **80**. The transport auger **66** serves as an example of a transport member that transports the toner T having been guided downward through the outlet path **70** and the inlet path **82** from one end side (toner cartridge **38** side) of the transport passage **80** to the other end side (developing device **32** side) of the transport passage **80** along the transport passage **80**. Hereafter, also for parts or the like other than the transport passage **80**, with respect to the intersecting direction, the toner cartridge **38** side and the developing device **32** side may be respectively referred to as a one end side and the other end side.

The transport auger **66** has a cylindrical shaft portion **66**A and a spiral-shaped blade portion **66**B, which is integrally formed with the shaft portion **66**A on an outer circumferential surface of the shaft portion **66**A. The transport auger **66** is rotatably supported by a pair of closing lids **28**A that close one and the other end portions of the transport pipe **28**.

As illustrated in FIG. **2**, the one end side of the shaft portion **66**A protrudes from one of the closing lids **28**A to the outside. A gear **68** is attached to the protruding portion of the shaft portion **66**A. The gear **68** is engaged with a gear **55**, which is secured to an output shaft **54**A of a motor **54**.

Furthermore, as illustrated in FIG. **6**, the transport pipe **28** has an open portion in a lower surface thereof on the other end side. An upper end portion of a connection pipe **71** is attached to this open portion. A lower end portion of the connection pipe **71** is connected to the developing device **32**.

In this structure, a rotational force is transmitted to the transport auger **66** via the gear **55** and the gear **68** when the controller **20** causes the motor **54** (see FIG. **2**) to operate. The toner T is transported from the one end side to the other end side of the transport passage **80** by the rotation of the transport auger **66**, and accordingly, the toner T is supplied to the developing device **32** through the connection pipe **71**.

Path Member

As illustrated in FIG. **5**, a cylindrical outlet member **72** is attached to the lower surface of the housing **38**A of the toner cartridge **38** on the rear side of the apparatus in the apparatus depth direction. As illustrated in FIG. **1**, the circular outlet path **70**, through which the toner T contained in the housing **38**A is transported to the transport pipe **28**, is formed by the outlet member **72**.

The inlet path **82**, through which the transport pipe **28** receives the toner T from the toner cartridge **38** through the outlet path **70**, is formed on the one end side in an upper surface of the transport pipe **28**.

Specifically, a cylindrical inlet member **84**, which extends in the intersecting direction, is attached to the upper surface of the transport pipe **28**, thereby forming the inlet path **82** having an elongated hole shape (slot shape). The dimension in the short side direction (dimension "G" in FIG. **1**) of the inlet path **82** having an elongated hole shape is substantially the same as that of the diameter of the circular outlet path **70** (diameter "E" in FIG. **1**).

A step member **86** is disposed between a lower end of the outlet member **72** and an upper end of the inlet member **84**. The step member **86** defines a step between the lower end of the outlet member **72** and the upper end of the inlet member **84**.

The step member **86**, the outlet member **72**, and the inlet member **84** define a path member **90**. The toner T in the housing **38**A is guided downward in the vertical direction by the path member **90**.

As understood from the above description, an inner circumferential wall of the path member **90** is enlarged stepwise. The area of an opening at an exit on a lower end side of the path member **90** is larger than the area of an opening at an entrance on an upper end side of the path member **90**.

As described above, the toner transport structure **78** guides the toner T downward in the vertical direction and transports the toner T in the intersecting direction that intersects the vertical direction. The toner transport structure **78** includes the path member **90** and the transport auger **66** and has the transport passage **80**.

Operation of Structure

Next, operations of the structure are described.

When the developing device **32** runs short of the toner T, the controller **20** (see FIG. **6**) causes the drive source (not shown) to operate so as to transmit a rotational force to the agitator **74** (see FIG. **5**) in the housing **38**A. Furthermore, as illustrated in FIG. **2**, the controller **20** causes the motor **54** to operate so as to transmit a rotational force to the transport auger **66** via the gear **55** and the gear **68**.

When the agitator **74** is rotated, the toner T in the housing **38**A is agitated while being transported toward the outlet path **70**. The toner T having been transported to the outlet path **70** by the agitator **74** is, as illustrated in FIG. **2**, delivered to the transport passage **80** through the outlet path **70** and the inlet path **82**, which are defined by the path member **90**.

The toner T having been received by the transport passage **80** is transported from the one end side to the other end side of the transport passage **80** by the transport auger **66** being rotated. The toner T having been transported to the other end side of the transport passage **80** by the transport auger **66** is supplied to the developing device **32** through the connection pipe **71** (see FIG. **6**).

Here, the toner T having been guided downward in the vertical direction by the path member **90** is transported by the transport auger **66** in the intersecting direction that intersects the vertical direction. That is, the transport direction of the toner T is changed. Thus, agglomeration of the toner T may occur due to degradation of toner transport performance at a position where the toner T transport direction is changed.

However, the area of the opening at the exit on the lower end side of the path member **90** is larger than the area of the opening at the entrance on the upper end side of the path member **90**. That is, the amount of the toner T that enters the outlet path **70** is smaller than (reduced compared to) the amount of the toner T allowed to pass through the inlet path **82**.

Thus, even in the case where toner T transport efficiency is degraded when the toner T transport direction is changed, agglomeration of the toner T caused by degradation of the toner T transport performance is suppressed compared to the case where the amount of the toner T that enters the outlet path **70** is similar to the amount of the toner T allowed to pass through the inlet path **82**.

In other words, in a toner transport path in which the toner T transport direction is changed, degradation of toner T transport performance is suppressed compared to the case where, in the path member **90**, the area of the opening at the entrance is substantially the same as the area of the opening at the exit.

In particular, nowadays, as the size of the particles of the toner T has been decreasing, the number of points per unit of volume, the points being points where the toner particles are in contact with one another, increases. This increases the effect produced by degradation of the toner T transport performance, and as a result, agglomeration of the toner T may occur during transportation. However, by using the structure according to the present exemplary embodiment, degradation of toner T transport performance is suppressed, and accordingly, agglomeration of the toner T during transportation is suppressed.

Since the inner circumferential wall of the path member **90** is enlarged stepwise, in comparison with the case where the inner circumferential wall of the path member **90** is enlarged so as to have an inverted funnel shape (dotted lines in FIG. **1**), the volume of the path member **90** is increased near the exit of the path member **90**. Thus, the toner T having entered the path member **90** is loosened near the exit of the path member **90**. As a result, in comparison with the case where the inner circumferential wall of the path member **90** is enlarged so as to have an inverted funnel shape, in the toner transport path in which the toner T transport direction is changed, degradation of toner T transport performance is suppressed.

Also, since degradation of toner T transport performance is suppressed, time required for maintenance of the image forming apparatus **10** is reduced.

Evaluation

Here, the toner T transport performance is evaluated by using the above-described toner transport structure **78**. Specifically, plural examples and a comparative example are evaluated in terms of toner T transport performance. In the plural examples, the shapes of the outlet path **70** and the inlet path **82**, which are formed by the path member **90**, are different from one another.

First Example

In a first example, as illustrated in FIG. **1**, the diameter (dimension E in FIG. **1**) of the circular outlet path **70** is set to 17 mm. In the elongated (slot-shaped) inlet path **82**, the dimensions in the long side direction (in the intersecting direction, dimension F in FIG. **1**) and in the short side direction (dimension G in FIG. **1**) are respectively set to 26 mm and 17 mm. The positional relationship between the outlet member **72** and the inlet member **84** are determined such that the center line Q of the inlet path **82** is coincident with the center line J of the outlet path **70**.

The height of the outlet member **72** (dimension K in FIG. **1**: length of the outlet path **70**) is set to 5 mm, and the height of the inlet member **84** (dimension L in FIG. **1**: length of the inlet path **82**) is set to 4 mm.

Second Example

In a second example, as illustrated in FIG. **3**, the dimension of the elongated (slot-shaped) inlet path **82** in the long side direction (in the intersecting direction, dimension M in FIG. **3**) is set to 21.5 mm, and the center line N of the inlet path **82** is shifted from the center line J of the outlet path **70** toward the other end side (to the right side in FIG. **3**) in the intersecting direction by 2.25 mm.

With such a structure, when seen in the vertical direction, with respect to the intersecting direction, an edge portion on the other end side of the exit of the path member **90** is disposed further toward the other end side than an edge portion on the other end side of the entrance of the path member **90**.

In this state, when seen in the vertical direction, with respect to the intersecting direction, an edge portion on the one end side of the exit of the path member **90** is superposed with the edge portion on the one end side of the entrance of the path member **90**.

Other specifications of the second example are similar to those of the first example.

Comparative Example

Referring to FIG. **7**, in the comparative example, an inlet path **100** has a circular shape similarly to the shape of the outlet path **70**. Thus, a path member **102** is uniformly shaped from its entrance to exit. Other specifications of the comparative example are similar to those of the first example.

Method of Evaluation

A certain amount of the toner T is caused to enter the transport passage **80** through the entrance of the path members **90** or **102**, and the amount of the toner T exiting the transport passage **80** on the other end side of the transport passage **80** is measured with respect to the passage of time.

Results of Evaluation

FIGS. **4**A, **4**B, and **4**C are graphs that respectively illustrate the results of evaluation with the first example, the second example, and the comparative example.

In each of the graphs, the vertical axis indicates the amount per unit time of the toner T that exits the transport passage **80** on the other end side of the transport passage **80** (dispensing rate in grams per second or "g/s"). The amount per unit time of the toner T that exits the transport passage **80** on the other end side of the transport passage **80** increases as the position on the vertical axis moves up.

The horizontal axis of each graph indicates the passage of time (dispensing time) in seconds ("sec").

As illustrated in FIGS. **4**A and **4**B, in the first and second examples, the toner T still exits the transport passage **80** on the other end side of the transport passage **80** even after a certain period of time has passed. That is, it is observed that agglomeration of the toner T does not occur during transportation.

As illustrated in FIG. **4**C, in the comparative example, the amount of the toner T that exits the transport passage **80** on the other end side of the transport passage **80** becomes 0 g/s after a certain period of time has passed. That is, it is observed that agglomeration of the toner T occurs during transportation.

As understood from the above-described results of evaluation, in the present exemplary embodiment, degradation of toner T transport performance is suppressed in the toner transport path in which the toner T transport direction is changed compared to the case where the areas of the openings of the entrance and the exit of the path member **90** are substantially the same.

In the present exemplary embodiment, the toner transport structure **78** is used in the toner transport path through which the toner T is supplied from the toner cartridge **38** to the developing device **32**. The toner transport structure **78** according to the present exemplary embodiment may be used, for example, in a toner transport path, through which the toner T having been collected from the image carrying body **24** by the collection blade **36** is transported to a collection box (not shown).

In the case where a transfer belt is also used as an image carrying body that carries a toner image in addition to a so-called photoconductor drum, the toner transport structure **78** according to the present exemplary embodiment may be used in a toner transport path through which the toner T collected from the transfer belt is transported to the collection box (not shown).

Although the inner circumferential wall of the path member **90** is enlarged downward in a stepwise manner in the above-described embodiment, the inner circumferential wall of the path member may be enlarged so as to have an inverted funnel shape.

Although the intersecting direction extends in a direction similar to the apparatus width direction in the above-described embodiment, the intersecting direction may be a direction other than a direction that extends similarly to the apparatus width direction as long as the intersecting direction intersects the vertical direction.

In the above-described embodiment, although it is not particularly described, when detaching the toner cartridge **38** from the apparatus body **10**A, in the path member **90**, the step member **86** is separated from the inlet member **84**. In addition, shutter members (not shown) are provided for the outlet path **70** and the inlet path **82**. The shutter members close the outlet path **70** and the inlet path **82** when the toner cartridge **38** is detached from the apparatus body **10**A.

The foregoing description of the exemplary embodiment of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiment was chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. A toner transport structure having a transport passage that extends in an intersecting direction that intersects a vertical direction, the toner transport structure comprising:

a path member that has an upper end and a lower end, an exit on a lower end side of the path member, and an entrance on an upper end side of the path member, the exit and the entrance having respective openings, the path member guiding toner downward in the vertical direction; and

a transport member disposed in the transport passage connected to the exit on the lower end side of the path member, the transport member transporting along the transport passage the toner having been guided downward by the path member,

wherein an area of the opening at the exit is larger than an area of the opening at the entrance,

wherein the transport passage has one end and another end, and the transport member transports the toner from one end side toward another end side, and

wherein the exit and the entrance have respective edge portions on the other end side of the transport passage, and the edge portion of the exit is disposed further toward the other end side than the edge portion of the entrance,

wherein the exit and the entrance have respective edge portions on the one end side of the transport passage, and the edge portion of the exit is disposed further toward the one end side than the edge portion of the entrance or is disposed the one end side same as the edge portion of the entrance.

2. The toner transport structure according to claim **1**,

wherein the path member has an inner peripheral wall that is enlarged downward in a stepwise manner.

3. An image forming apparatus comprising:

the toner transport structure according to claim **1**;

an image carrying body, an electrostatic latent image being formed on the image carrying body; and

a developing member that develops the electrostatic latent image formed on the image carrying body into a toner image with the toner transported by the toner transport structure.

4. An image forming apparatus that forms an image on a transfer target material with toner, the image forming apparatus comprising:

an image carrying body that holds a toner image formed thereon;

a transfer member that transfers the toner image formed on the image carrying body onto the transfer target material;

a collection member that collects the toner that has not been transferred onto the transfer target material by the transfer member and remains on the image carrying body; and

the toner transport structure according to claim **1** used to transport the toner collected by the collection member.

5. The toner transport structure according to claim **1**, wherein the transport member comprises a spiral blade portion and the area of the opening at the exit is disposed directly above the spiral blade portion.

6. The toner transport structure according to claim **5**, wherein the transport passage extends upstream and downstream of the opening at the exit.

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